



# Space Launch System

## Highlights

November 2013



## NASA Tests Space Launch System Autopilot Technology on F/A-18 Jet

NASA has completed the first tests with an F/A-18 research jet to evaluate the autonomous flight control system for the SLS.

The system, called the Adaptive Augmenting Controller, will allow SLS to respond to vehicle and environmental variations—such as winds or vehicle flexibility—after it blasts off the launch pad and heads toward space. This is the first time a flight control system for a NASA rocket is being designed to adjust autonomously to unexpected conditions during actual flight rather than pre-flight predictions. This ability to make real-time adjustments to the autopilot provides enhanced performance and increased safety for the crew.

The tests were flown Nov. 14-15 out of NASA's Dryden Flight Research Center at Edwards Air Force Base, Calif. During the flights, more than 40 tests were conducted using SLS-like trajectories.



NASA

The system was evaluated in different scenarios for up to 70 seconds at a time to match the rocket's dynamics for the majority of its flight from liftoff to solid rocket booster separation.

For the full story on the F/A-18 testing at Dryden, and the young engineers working on the project, [click here](#). (NASA)

## Preparing for EFT-1

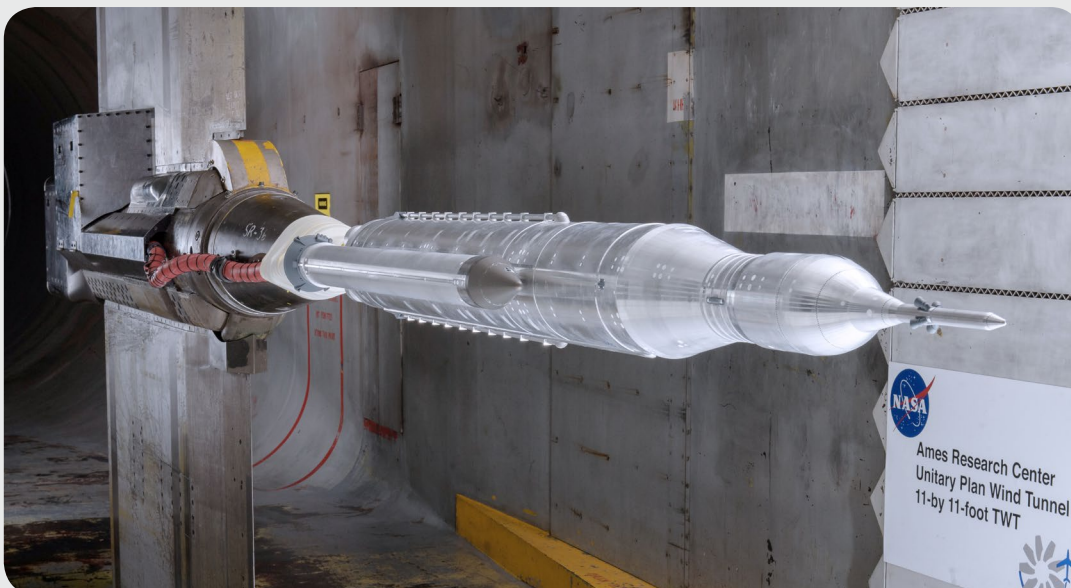


The diaphragm above—which will keep gases away from the spacecraft during EFT-1—was joined to an adapter prototype for pressurized testing. For the test, the adapter was sealed, and a vacuum pump was connected to the diaphragm. The vacuum pressure simulates atmospheric conditions the hardware may experience during the mission. Now that pressure testing is complete, the diaphragm will be put into the flight adapter, and cables will be installed. For more information and a video on the pressure test, [click here](#). (NASA/MSFC)

A technician (below) at NASA's Marshall Space Flight Center in Huntsville, Ala., applies the finishing touches on the stage adapter that will connect NASA's Orion spacecraft to a United Launch Alliance Delta IV rocket for EFT-1 in late 2014. The top coat for the adapter is a special paint that protects the hardware and its components, like sensors, from electrical discharge on ascent. (NASA/MSFC)



## Wind Tunnel Testing Used to Understand the Unsteady Side of Aerodynamics



A scale model of the SLS is tested in an 11-by-11-foot transonic wind tunnel at NASA's Ames Research Center. The tests will be used to enhance the design and stability of the SLS. Also included in this test series were critical buffet tests, which determine how air affects the vehicle at low frequencies. For the full story on the wind tunnel tests, [click here](#). (NASA)



# Spaceflight Partners: Honeywell International

*EDITOR'S NOTE: Every month, SLS Highlights turns the spotlight on one of the industry partners helping to create the largest rocket ever built for human space exploration. In this issue, we profile Honeywell International in Fla.*

When the SLS launches off the pad on future missions, each of its RS-25 booster engines will be equipped with an engine controller—an integrated set of computers that monitors performance and controls all engine functions.

Honeywell International in Clearwater, Fla.—in collaboration with Aerojet Rocketdyne of Canoga Park, Calif.—is developing the engine controllers. Honeywell is preparing to deliver the first engineering model hardware for testing at NASA's Stennis Space Center in Bay St. Louis, Miss., in the second quarter of 2014.

“This is our dress rehearsal for the flight hardware that we'll begin delivering in the second quarter of 2015,” said Gus Papadopoulos, deputy project manager for the RS-25 controllers at Honeywell.

The RS-25, the original name for what became known as the space shuttle main engine, boosted the space shuttles on all 135 launches with 100 percent ascent mission success. Designed and built by Aerojet Rocketdyne for NASA, the engines are being repurposed to power the core stage of the SLS to low-Earth orbit and beyond.



Honeywell

Honeywell supplied the main engine controllers for shuttle missions and will use a second-generation controller based off of the J-2X engine design for the RS-25. This is the first step in establishing a common engine controller for NASA missions.

One engine controller will be mounted to each of the SLS's main engines to monitor and maintain control of each engine's performance. Each controller will continuously check its main engine system against performance requirements, perform engine health sensor acquisition and transmission, and provide fault detection and response capability.

## Members of Alabama Legislature Visit Marshall to See SLS Progress



Marshall Center engineer Lisa Bates, left, gives a tour of the Thrust Vector Control Test Lab to members of the Alabama State Legislature. The representatives toured the Marshall Center and were presented an overview of the SLS Program. (NASA/MSFC)

# Laying the Groundwork for Best Advanced Boosters for SLS

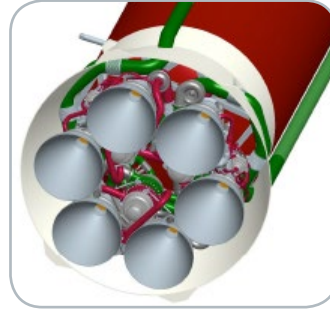
Pop quiz—what’s more powerful than SLS’s five-segment solid rocket boosters and yet affordable for long-term exploration, while still being compatible with the rocket’s core architecture? Would it help if it were a multiple-choice question?

While most of the SLS Program works towards the first flight in December 2017, the SLS Advanced Development Office is paving the way for the future evolution of the launch vehicle into the most powerful rocket ever flown.

A cornerstone of those efforts is the Advanced Booster Engineering Demonstration and Risk Reduction (ABEDRR) project to lay the groundwork for the more powerful replacements for the shuttle-derived solid boosters that will fly as part of the initial 70-metric-ton configuration of SLS. Through the ABEDRR project, initial concept studies are being conducted on multiple options for advanced boosters for the vehicle’s evolved 130-ton configuration. The goal is to mature the concepts in order to make a more informed decision when the time comes to select a booster design for the evolved SLS.

The first ABEDRR contracts were awarded in October 2012, and the project very quickly reached an early milestone with the test-firing of a gas generator from an Apollo-era F-1 engine. Aerojet Rocketdyne has been conducting research into creating a modernized version of the Saturn V engine that could be used to power SLS boosters. The F-1B is one of two liquid-kerosene (RP-1)/liquid-oxygen engine concepts being studied by Aerojet Rocketdyne in the project, the other being a dual-combustion chamber engine. The company is currently working toward a full-scale test firing of one of the chambers and main injectors, capable of producing 550,000 pounds of thrust.

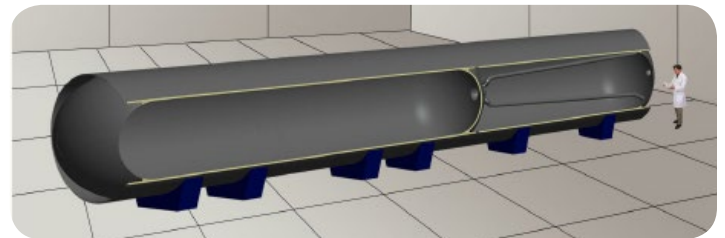
Aerojet Rocketdyne has partnered with Dynetics on ABEDRR work, with the Huntsville-based company performing demonstration work on a more-affordable booster structure that could be used with one of the RP-1 engines. Full-scale barrel section panel test articles have been shipped to the Marshall Space Flight Center and welded into barrels, and domes will soon be arriving to complete the tank test articles.



*Aerojet Rocketdyne*



*Dynetics*



*Northrop Grumman*

Also working on an RP-1 booster concept is Northrop Grumman, which is taking an integrated approach to the booster, performing risk reduction work involving both a sub-scale demonstrator of a composite tank structure and a test article for a kerosene-fueled aerospike engine. Northrop Grumman is currently constructing a test stand that will be used for study of the structural test article.

Meanwhile, ATK, the prime contractor for the solid-fuel boosters for the first flights, is working on concepts for next-generation solid rocket boosters, taking a blank-slate approach using state-of-the art technologies. During the first year of the project, ATK has constructed test articles from composite materials, and has conducted research into alternate propellant mixtures for more powerful solid boosters.



*ATK*

Through this work, the teams—and the SLS Program—are gaining an unprecedented level of understanding of the benefits and challenges presented by each of the concepts under review, providing a substantial head-start in the evolution of SLS into a vehicle capable of opening the solar system for human exploration.



## SLS On the Road...



Shannon Raleigh, left, and Trey Cate, center, talk to students about SLS Nov. 6 at the University of Alabama in Tuscaloosa. Raleigh and Cate—along with other Alabama alumni who now work at the Marshall Center—were in “Roll Tide” country for a series of events highlighting the SLS Program. (NASA/SFC)




Garry Lyles, SLS chief engineer, shares information about SLS with some 300 students during a panel discussion at the University of Alabama’s College of Engineering. Serving on the panel with Lyles were Michael Kynard, manager of the SLS Liquid Engines Office; Sharon Cobb, assistant program manager for the SLS Program Office; and Michelle Taylor, a Boeing engineer supporting the SLS Program Office. (NASA/MSFC)



### Eric Gilligan

Aerospace Engineer





To find out more about the people who are building SLS, [click here](https://www.nasa.gov/sls).



Students attending Space Camp eagerly ask questions of the deep space exploration panel Nov. 18 at the MAVEN public viewing event at the U.S. Space & Rocket Center in Huntsville. The discussion featured Paul Bookout, Deep Space Habitat Concept Demonstrator project manager; Bill Cooke, Meteoroid Environments Office lead; Sharon Cobb, SLS assistant program manager; David Smitherman, Advanced Concepts study lead; and Les Johnson, deputy manager of the Advanced Concepts Office. (NASA/MSFC)

### SLS on Deck:

- Boosters avionics testing
- SMAT testing begins
- VAC foundation cure completion

For more SLS news, updates and resources, visit [www.nasa.gov/sls](https://www.nasa.gov/sls)

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